FTD-HC-23-0298-72

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by

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English pages: 4

Source: Czech Patent Nr 134454, 1969,
pub. 10 June 1967, pp. 1-2.

Requester: ASD

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UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Foreign Technology Division Air Force Systems Command U. S. Air Force	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP
3. REPORT TITLE REFRACTORY ALLOY RESISTANT TO CORROSION AND WEAR AT INCREASED TEMPERATURES	
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Translation	
5. AUTHOR(S) (First name, middle initial, last name) K. Lobl, Z. Lehky	
6. REPORT DATE 10 June 1967	7a. TOTAL NO. OF PAGES 4 7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. b. PROJECT NO. 7343 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) FTD-HC-23-0298-72 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
10. DISTRIBUTION STATEMENT Approved for public release; distribution unlimited.	
11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Foreign Technology Division Wright-Patterson AFB, Ohio

13. ABSTRACT

Alloys contg. NI 7 to 12, CR 11 to 20, C 0.02 to 0.15, NB 0.6 to 1.2, V 0.05 to 2, MN 3.2 to 6.8, SI 4 to 6, MO 3 to 7 percent, and FE the rest, MN plus SI plus MO less than 15 percent, and the ratio MN to MO 1:1.1 to 1.5 are suitable for surfacing owing to the formation of hard phases which ppt. during heat treatment. CR SUB3 SI, carbides (MC, M equals Metal), and the CHI and Laves phases are the hardening components. NB stabilized the alloy against formation of carbides of the M SUB6 C and M SUB23 C SUB6 types, which decreases resistance to intercryst. corrosion. The coatings have hardnesses of 38 to 45 hrc, which can be increased by isothermal heating at 700 to 750 degrees. They are produced by an elec. arc with a basic electrode. [AA1047333]

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Metallurgic Patent						
Wear Resistance						
Corrosion Resistance						
Intergranular Corrosion						
Chromium Carbide						
Manganese Alloy						
Molybdenum Alloy						

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REFRACTORY ALLOY RESISTANT TO CORROSION AND WEAR AT INCREASED TEMPERATURES

[Article by Engr. Karel Loebl, Csc., from Prague, and Zdenek Lehky from Vamberk; Prague, Patentovy Spis [Patent Register], Czech, Patent No. 134454, 1969, pp 1-2]

Steel parts of machinery, the surface of which must resist wear and tear at increased temperatures and retain maximum hardness and resistance to corrosion, erosion, and jamming, are subjected to the process of hard facing by using hard alloys of the stellite type, which contain as much as 65 percent cobalt, as much as 20 percent tungsten, and as much as 32 percent chrome.

Parts made of alloys of this type are customarily used only up to temperatures of 600°C, because at higher temperatures they are subject to rapid wear and tear and seizing, and as a result lose their functional reliability.

That is why alloys have been prepared on the basis of cobalt, chrome, and tungsten, with the addition of 5 to 10 percent molybdenum, which can also be used in environments at temperatures over 600°C. These are hard-faced by using an oxy-acetylene flame. However, the disadvantage of these alloys is their low resistance to aggressive environments, for example free ions of chlorine. This disadvantage is not eliminated entirely even by another alloy according to patent No. 109884, even though the content of tungsten in it is reduced to a maximum of 3.0 percent, which with the average content of 1.0 percent carbon, 3 percent molybdenum and 28 percent chrome reduces the possibility of intra-crystalene corrosion in the area of eutectic carbides, because in this case an independent tungsten carbide is not formed in contrast to M_6C carbide which occurs in another well-known alloy and causes the given type of corrosion, for example in certain highly oridating decontamination environments of pipes in atomic electric power plants.

Furthermore, in certain designs of atomic power stations an alloy with cobalt hard-facing can become radioactive in case of breakdowns.

This disadvantage -- particularly in case the material is used in the construction and maintenance of atomic electric power plants -- is eliminated by the alloy described according to the invention, where the use of the alloy is considered primarily for sealing areas of closing parts of high-pressure fittings and special castings, guide rails, guide bars, and so on.

The alloy according to the invention contains -- in addition to iron -- 7.0 to 12.0 percent nickel, 11.0 to 20.0 percent chrome, 0.02 to 0.15 percent carbon, 0.6 to 1.2 percent niobium or a mixture of niobium and tantalum, 0.05 to 2.0 percent vanadium, 3.2 to 6.0 percent manganese, 4.0 to 6.0 percent silicon, 3.0 to 7.0 percent molybdenum, while at the same time the sum total of manganese, silicon and molybdenum is 15.0 percent at maximum, and the ratio of the amount of manganese to the amount of molybdenum is 1 : 1.1 to 1.5.

The presence of the elements in the amounts and ratios mentioned above makes it possible to form hard phases, which precipitate from the basic metallic substance in the course of hot working.

A facing of the above composition is rated at 38 to 45 HRc, which is reached right after the facing operation; its hardness can be increased by isothermic calcination at temperatures of 700 to 750°C.

The structural element which does the hard-facing in this case is particularly chromium silicide Cr_3Si, and then the chi phase and the Laves phases. In addition, a carbide of the MC type is always persent in these structures. Carbides of the M_6C and $M_{23}C_6$ type occur only in those cases when carbon is not adequately stabilized by the presence of niobium, or by the technological mixture of Niobium and tantalum. However, if $M_{23}C_6$ carbide occurs in the structure, the alloy is usually not resistant to corrosion between crystals, and hard-facing actually results in a deterioration of its resistance to corrosion. For that reason -- according to the invention -- carbon is to be bonded in the alloy only to a carbide of the MC type.

The alloy according to the invention has a hardness of 25 to 35 HRc at 600°C, and is characterized at that temperature by good resistance to wear and tear, corrosion, erosion, and retains excellent resistance against burning if exposed to normalizing and austenitic temperatures suitable for thermal processing of the majority of structural steels which can be considered as material for parts which are hard-faced with this new alloy.

As a rule, the alloy according to the invention is applied in hard-facing by means of a basic electrode involving the use of an electric arc, with the electrode connected to the positive pole of the welding aggregate, or castings are made directly from the alloy.

An example of such material are alloys with the following contents (percent weight):

Ozn. slitiny	C	Mn	Si	Cr	Ni	Mo	V	W	B	Nb
A	0,10	4,05	4,95	14,35	9,15	5,30	0,25	—	—	1,05
B	0,105	4,25	4,98	13,05	9,50	5,04	0,19	0,45	—	1,10
C	0,13	3,75	5,30	16,21	10,46	5,00	0,25	—	—	1,13
D	0,13	5,06	3,60	14,40	8,89	5,50	0,15	—	0,09	1,07

Key: 1. Designation of alloy.

The alloy made according to the invention, either cast or rolled into small bars, can be used very well for hard-facing by electric arc in an atmosphere of argon by means of a tungsten electrode which does not melt. Or, if it is equipped with a suitable ceramic cover of known composition, it can be used for hard-facing by applying the usual welding technology by means of an electric arc. The ceramic cover can be made for example from the well-known mixture of 50 to 70 percent limestone, 10 to 25 percent aluminum powder, 10 to 30 percent fluor spar, and as much as 3 percent carbosaphire.

Other core material which proved suitable in the production of electrodes was wire made from $Cr_{18}Ni_{10}Mo_{2}Nb$ steel and the remaining elements, i.e., manganese, molybdenum, silicon, and vanadium, as well as possibly tungsten and boron were present in the basic container in such an amount that the resulting weld corresponded fully in terms of its chemical composition to the alloy according to the invention on its first run. This electrode has a liquid slag which can be eliminated easily and produces a compact weld, if one properly applies the technology which is generally known with regard to the welding of austenitic chrome-nickel steels which are resistant to corrosion.

The alloy according to the invention is suitable particularly for use in sealing areas of high-pressure fittings used in the power industry, chemical industry, and food industry, for making parts of extruding and forging presses, as well as for special purpose machinery parts. It is also characterized by good castability and can be used in making castings which are very demanding.

Welds of the chemical composition specified in the invention prove excellent for sealing areas of fittings which are cleaned or decontaminated by weak solutions of hydrochloric acid (up to 5 percent), sulfuric acid (up to 10 percent), phosphoric acid (up to 10 percent), and nitric acid (up to 5 percent).

The addition of nitrogen in an amount of up to 0.28 percent proved advantageous for the purpose of increasing the resistance of the weld 10 to 22 percent at room temperature as well as at higher temperatures.

Subject of the Patent

1. Refractory alloy resistant to corrosion, which resists wear at higher temperatures, based on iron, chromium, nickel, manganese, molybdenum, and silicon, in which the carbon present is fully combined with niobium or a mixture of niobium and tantalum to form a carbide of the MC type, characterized by the fact that in addition to iron it contains 7.0 to 12.0 percent nickel; 11.0 to 20.0 percent chromium; 0.02 to 0.15 percent carbon; 0.60 to 1.20 percent niobium or mixture of niobium and tantalum; 0.05 to 2.0 percent vanadium, as well as 3.2 to 6.8 percent manganese; 4.0 to 6.0 percent silicon, and 3.0 to 7.0 percent molybdenum, while the sum total of the content of manganese, silicon, and molybdenum is 15 percent maximum, and the ratio of the amount of manganese to the amount of molybdenum is 1 : 1.1 to 1.5.

2. Alloy according to point 1, characterized by the fact that it contains up to 3 percent boron.

3. Alloy according to points 1 to 2, characterized by the fact that it contains up to 2.0 percent tungsten.

4. Alloy according to point 1, characterized by the fact that it contains up to 0.28 percent nitrogen.